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(54) X-ray tube

(57) An X-ray tube consisting of a cylindrical metal housing 1 whose ends are closed by ceramic insulators 4,5 supporting the anode 2 and the cathode 3, and having electrical connectors 10 projecting from the insulators 4,5, has discs 12 of rubber or plastics material located on these connectors 10 for compression between the insulators 4,5 and high-voltage plugs 6,7, the facing surfaces of the insulators 4,5, discs 12 and plugs 6,7 being so shaped that air is expelled from the inside radially outwardly when the plugs 6,7 are pressed home and locked in position.

Fig.1

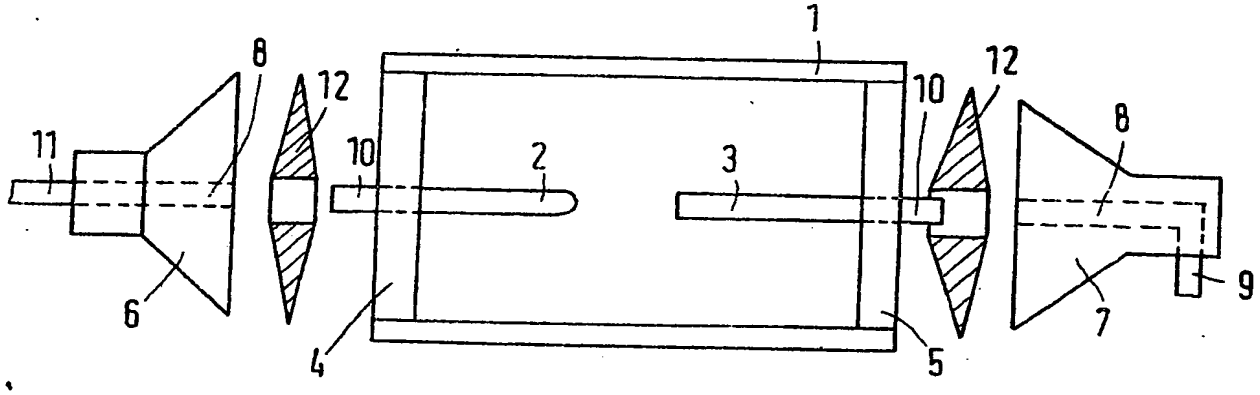

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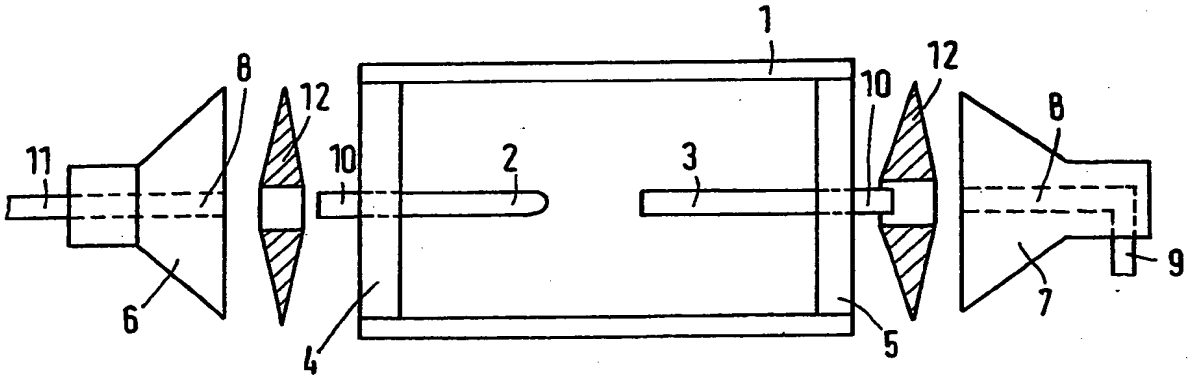
Fig.1



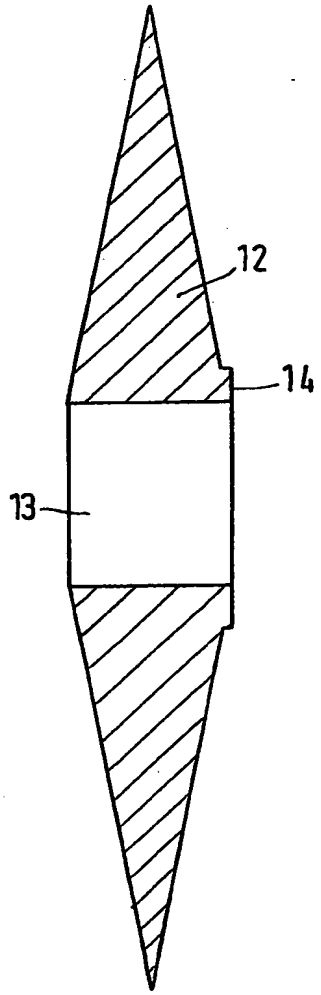


Fig.2

SPECIFICATION

X-ray tub

The invention relates to an X-ray tube consisting of a cylindrical metal housing and ceramic insulators with high-voltage bushings mounted at both ends of the metal housing and with detachable high-voltage plugs to which are connected high-voltage cables; the ceramic insulators and the high-voltage plugs being constructed with corresponding plane surfaces which, when assembled, face one another.

An X-ray tube is known with a cylindrical vacuum envelope (DT-OS 24 48 497) on whose faces the high-voltage connections to the anode and the cathode are arranged. The vacuum envelope is at least partially of metal and is at earth potential. On the faces there are annular ceramic parts in whose openings the high-voltage connectors are inserted and sealed by vacuum-tight seals. The high voltage connector bushings or the anode and cathode are connected to a high-voltage source via high-voltage plugs. The electric field at the transition points between the ceramic insulators and the high-voltage plugs is particularly critical because creeping discharges may occur there if the connection between the ceramic insulators and the high-voltage plugs is imperfect. In the known X-ray tube it is proposed to solve this problem by constructing the outer face of the annular ceramic part at a certain angle to the axis of the X-ray tube, which angle is 45° or below. It has, however, been found that even with such a construction of the transition surfaces, the electric field is not perfectly controlled. Discharges may result even at the boundary surfaces which are oblique to the axis of the X-ray tube.

It is a main object of the invention therefore to construct an X-ray tube that the electrical stability is increased as compared with known tubes. At the same time, the dimensions of the X-ray tube are not increased so that, with tubes of equal size a tube according to the invention has a high electrical stability or, in the case of tubes of equal electrical stability, a tube according to the invention is smaller than a known tube.

According to the invention there is provided an X-ray tube consisting of a cylindrical metal housing and ceramic insulators with high-voltage bushings at both ends of the metal housing and with detachable high-voltage plugs connected to high-voltage cables, the ceramic insulators and the high-voltage plugs being constructed with corresponding plane surfaces which, when assembled face one another, characterised in that between each ceramic insulator and high-voltage plug, there is located a disc of rubber of plastics material whose thickness tapers from the inside towards the outside and which has a passage for the high-voltage connection.

Air spaces where high electrical stresses may occur are thus avoided. This is because between the ceramic insulators and the high-voltage plugs, there are interposed rubber or plastics discs each of which is so shaped that in its inner region in the proximity of the high-voltage bushing it has a greater thickness than in its external region at the outer periphery. When assembled the high-voltage plug is pressed from the inside against the disc and the disc is pressed against the ceramic insulator so that any air which may be present is pressed from the inside towards outside, so that in the assembled state no intermediate space is present. To this end the disc may be constructed so that its thickness decreases gradually from the middle towards the edge; this transition may be curved or rectilinear.

For example, each disc may be of conical or double conical construction with two cones adjoining one another at their bases surfaces and having a comparatively small height.

Furthermore, each disc may have a centring projection or any projecting part whereby, during assembly of the plug and insulator, the disc assumes an exactly defined position and, during the further assembly process, namely when the parts are being pressed together, does not move or change its position.

In another embodiment of the invention th disc may be formed from a material which has a lower insulation strength than the material of the ceramic insulator and the high-voltage plug. In this way the disc acts, in effect, as a fuse since it represents the electrically weakest part of the whole arrangement. Accordingly, any flash-over or disruptive discharge may occur in the region of or inside the disc, and the ceramic insulator and the high-voltage plug are not destroyed by this flash-over or disruptive discharge. After such a disruptive discharge or flash-over the disc can readily be exchanged and replaced by a new disc.

In order that the invention may be more clearly understood some embodiments thereof will now be described, by way of example, with reference to the accompanying drawings in which:–

Figure 1 is a diagrammatic representation of an X-ray tube according to the invention, in which the individual parts are shown before assembly and not to scale, and

Figure 2 is, not-to-scale, a cross-section through a disc illustrated in Fig. 1.

The X-ray tube shown in Fig. 1 consists of a metal housing 1 of substantially cylindrical shape which has a window (not shown) for the emergence of X-ray radiation. Inside the metal housing 1 an anode 2 and a cathod 3 are secured to ceramic insulators 4 and 5. The ceramic insulators 4 and 5 are disc-shaped and are joined to the metal housing 1 in any vacuum-tight manner. High-voltage

bushings for the anode 2 and the cathode 3 pass through the ceramic insulators 4 and 5. Outside the ceramic insulators 4 and 5, high-voltage plugs 6 and 7 are shown.

The high-voltage plug 6 on the left-hand side is a conventional plug, whereas the high-voltage plug 7 is constructed of angular form. Inside each of the high-voltage plugs 6 and 7 there is shown purely diagrammatically a high-voltage line which is connected to cables 9 and 11. Projections 10 on the ceramic insulators 4 and 5 are connected to the anode 2 or the cathode 3 and are so constructed that they connect with high-voltage connectors 8 in the high-voltage plugs 6 and 7. Between the ceramic insulator 4 and the high-voltage plug 6 and between the ceramic insulator 5 and the high-voltage plug 7 there are located discs 12 of plastics material, shown in cross-section.

In Fig. 2 one disc 12 is shown enlarged and not to scale. The disc 12 consists of two cones which adjoin one another at their bases. The height of the cones is comparatively small in proportion to the diameter of the cones. In the middle of the disc 12 there is a passage opening 13 which is so dimensioned that a projection 10 can pass through this passage 13. Furthermore, the disc 12 has on one side an annular projection 14 which is dimensioned to fit into a corresponding recess in one of the high-voltage plugs or in one of the ceramic insulators.

During assembly, first the discs 12 are placed over the projections 10 on both sides of the X-ray tube, then the high-voltage plugs are pressed from both sides against the discs 12, during which operation the discs deform in such a manner that the air present between each disc and the ceramic insulator or plug is displaced radially from the inside towards the outside. In this manner a high insulation strength is produced between the metal cylinder 1 which is at earth potential and the projecting parts 10 or the bushings 8 which are at high voltage. Means, not shown, ensure that the connections between the ceramic insulators and the plugs are not loosened but are held pressed together.

Each disc 12 may be made with rounded off dges in the region of the passage opening 13. For example, the comparatively sharp edges shown in Fig. 2 can be rounded off or the rounding off may be so effected that the passage opening 13 is of annular form.

Furthermore, the surface or the region of the surface of the passage opening 13 may be provided with or filled with a semi-conductive material in order to achieve a kind of field smoothing. This may be achi ved for example by painting with, or mixing in, a s mi-conductive material, but it is also possible to spray around an appropriate ring on the plastics disc 12 during pr duction of the disc.

In another mbodiment th re may be inserted betwe n each ceramic insulator and high-voltage plug, a disc with constant dimensions; the ceramic insulators and/or the high-voltage plugs being constructed with a oblique faces in order to achieve the same objective, namely to displace the air from the inside to the outside during assembly of the parts.

CLAIMS

1. An X-ray tube consisting of a cylindrical metal housing and ceramic insulators with high voltage bushings at both ends of the metal housing and with detachable high-voltage plugs connected to high-voltage cables, the ceramic insulators and the high-voltage plugs being constructed with corresponding plane surfaces which, when assembled face one another, characterised in that between each ceramic insulator and high-voltage plug, there is located a disc of rubber or plastics material whose thickness tapers from the inside towards the outside and which has a passage for the high-voltage connection.

2. An X-ray tube according to Claim 1, characterised in that the disc is constructed in the form of two cones of small height and whose base surfaces abut.

3. An X-ray tube according to Claim 1 or Claim 2, characterised in that the disc has a centering projection on at least one side in the region of the passage.

4. An X-ray tube according to Claim 3, characterised in that an internal concentric part of the disc comprising a semi-conductive elastic material with rounded cross-section and that the semi-conductive material is in electrical contact with central projections on the insulators.

5. An X-ray tube according to any one of Claims 1 to 4, characterised in that the disc is of a material with lower insulation strength than the material of the ceramic insulators and the high-voltage plugs.

6. An X-ray tube substantially as herein described with reference to the accompanying drawings.

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